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Sesimic Evaluation Of Multistoried Building With Ground Soft Story And With Infills By Using Etabs

K.Sugamya[1], K Jaya Prakash[2]
[1]PG Scholar, Pydah College of Engineering, Kakinada, AP, India.
[2]Assistant Professor, Pydah College of Engineering, Kakinada, AP, India

ABSTRACT
Recent building codes for seismic design and evaluation in Europe and American feature performance based criteria that entail the estimation of inelastic response of the building due to seismic. These seismic demands can be accurately determine by employing methods of nonlinear time history analysis. Simplified methods based on nonlinear static analysis, known as pushover analysis method and linear dynamic analysis, known as time history analysis method, have been developed by several regulations to satisfy the performance based criteria for seismic design and evaluation of buildings. This thesis deals with multistory buildings with open (soft story) ground floor are inherently vulnerable to collapse due to seismic loads, their constructions is still widespread in develop nations. Social and functional need to provide car parking space at ground level far outweighs the warning against such buildings from engineering community.

In this study, 3D analytical model of multistory building have been generating for multistoried building model and analyzing using structural analysis tool 'ETABS'. To study the effect of models with ground soft and infill's during earthquake, seismic analysis both linear static(response spectrum method) , linear dynamic analysis(time history analysis) as well as non linear static(pushover method) procedure have to be perform. The analytical model of building includes all important components that influence the mass, strength, stiffness of the structure.

The deflections at each story have to be compare by performing equivalent static, response spectrum method as well as time history analysis also be perform to determine capacity, demand and performance level of the considering models. Numerical results for the following seismic demands considering the inelastic behavior of the building, ductility coefficients of structures.

KEY WORDS: soft story, ground soft, infill, mass, strength, stiffness, inelastic behavior, drift ratio, ductility coefficients .

INTRODUCTION

1.1 GENERAL

The capacity of structural members to undergo inelastic deformations governs the structural behavior and damageability of multi-story buildings during earthquake ground motions. From this point of view, the evaluation and design of buildings should be based on the inelastic deformations demanded by earthquakes, besides the stresses induced by the equivalent static forces as specified in several seismic regulations and codes. Although, the current practice for earthquake-resistant design is mainly governed by the capacity of structural members to undergo inelastic deformations governs the structural behavior and damageability of multi-story buildings during earthquake ground motions. From this point of view, the evaluation and design of buildings should be based on the inelastic deformations demanded by earthquakes, besides the stresses induced by the equivalent static forces as specified in several seismic regulations and codes. Principles of force-based seismic design, there have been significant attempts to incorporate the concepts of deformation-based seismic design and evaluation into the earthquake engineering practice. In general, the study of the inelastic seismic responses of buildings is not only useful to improve the guidelines and code provisions for minimizing the potential damage of buildings, but also important to provide economical design by making use of the reserved strength of the building as it experiences inelastic deformations. In recent seismic guidelines and codes in Europe and USA, the inelastic responses of the building are determined using nonlinear static methods of analysis known as the pushover methods.

Pushover methods are becoming practical tools of analysis and evaluation of buildings considering the performance-based seismic philosophy. This is evident by the recent implementation of pushover methods in several international seismic guidelines and codes, such as the Federal Emergency Management Agency standard 273 (FEMA-273), Euro-Code 8 (EC-8) and International Building Code

(IBC-2003). In these seismic regulations, pushover methods of analysis such as the N2-method and the capacity spectrum method are recommended for determining the inelastic responses of the building due to earthquake ground motions. One main step in these pushover methods of analysis for determining the seismic demands is the construction of the pushover curve of the building by using an adequate lateral load pattern simulating the distribution of inertia forces developed through the building when subjected to an earthquake. This pushover curve represents the lateral capacity of the building by plotting the nonlinear relation between the base shear and roof displacement of the building. The intersection of this pushover curve with the seismic demand curve determined by the design response spectrum represents the deformation state at which the performance of the building is evaluated.

Simplified approaches for the seismic evaluation of structures, which account for the inelastic behavior, generally use the results of static collapse analysis to define the global inelastic performance of the structure. Currently, for this purpose, the nonlinear static procedure (NSP) which is described in FEMA-273/356 and ATC-40 (Applied Technology Council, 1996) documents are used. Seismic demands are computed by nonlinear static analysis of the structure subjected to monotonically increasing lateral forces with an invariant height-wise distribution until a predetermined target displacement is reached.

Nonlinear static (pushover) analysis can provide an insight into the structural aspects, which control performance during severe earthquakes. The analysis provides data on the strength and ductility of the structure, which cannot be obtained by elastic analysis. By pushover analysis, the base shear versus top displacement curve of the structure, usually called capacity curve, is obtained. To evaluate whether a structure is adequate to sustain a certain level of seismic loads, its capacity has to be compared with the requirements corresponding to a scenario event.

Performance Based Engineering (PBE) in association with existing concepts of earthquake resistant design requires nonlinear analysis to obtain estimates of deformations for damage assessment for different levels of earthquakes. In the performance based procedure, the desired levels of seismic performance for a building for specified levels of earthquake ground motion are specified. The performance is checked in terms of post elastic deformations. ATC-40 gives the Capacity Spectrum Method for implementing PBE for buildings. It uses Nonlinear Static Pushover (NSP) analysis to develop the capacity curve (a plot of base shear Vs roof displacement).

In this dissertation, hypothetical multistoried buildings (i.e., twelve storied and nine storyed with infill and with ground soft story) located in zone V of medium soil sites has been analyzed and designed for load combinations given in code and evaluated using pushover analysis.

1.2 Dissertation Organization

The dissertation is divided into six chapters as follows First chapter is introduction work

Second chapter entitled Review of Literature described in detail the various works conducted by the researchers to understand the behavior of masonry infill and ground soft frame and their effect on strength requirement, for different types of buildings by seismic analysis and summary of literature need for the present investigation and describes the objective and scope of the present study or organized in the project. This chapters describes the importance of the study.

Third chapter includes different seismic analysis procedures such as linear, non-linear static and linear dynamic analysis. It also gives introduction to hinges and their properties. It includes detailed procedure of pushover analysis and graphical representation of pushover curves.

Fourth chapter provide complete details of different models which has used in this dissertation and modelled in ETABS software with their evaluation and 3D views.

Fifth chapter is discussion of results by considering different parameters of the building model.

Sixth chapter gives summary, conclusion and further scopes of the study, and at last reference.

INFILL WALLS

The infill wall is the supported wall that closes the perimeter of a building constructed with a 3-d frame work structure,therefore the structural frame ensures the bearing function where as the infill wall serves to separate inner and outer space,filling up the boxes of outer frames. The infill wall has the unique static function to bear its own weight.The infill wall is an external vertical opaque type of closure .these walls are differ from normal walls as they are non load bearing.

3.1BENEFICIAL INFLUENCE OF MASONRY INFILL WALLS ON SEISMIC PERFORMANCE OF RC FRAME BUILDINGS: INTRODUCTION

Most reinforced concrete (RC) frame buildings in developing countries are in filled with masonry walls. Experience during the past earthquakes has demonstrated the beneficial effects as well as the ill-effects of the presence of infill masonry walls. In at least two moderate earthquakes (magnitude 6.0 to 6.5 and maximum intensity VIII on MM scale) in India, RC frame buildings with brick masonry in fills have shown excellent performance even though most such buildings were not designed and detailed for seismic response [Jain et al, 1991; 1997]; these buildings are characterized by fairly uniform configuration and small panel size (typically about 2.7m × 3.5m with 0.23m masonry thickness). The design codes have, however, been mainly focusing on the malefic effects. The seismic design of masonry in filled RC frame buildings is handled in different ways across the world. Some of the prevalent design practices are:

• Infills are adequately separated from the RC frame such that they do not interfere with the frame under lateral deformations. The entire lateral force on the building is carried by the bare RC frame alone.

• Infills are built integral with the RC frame, but considered as non-structural elements. The entire lateral force on the building is carried by the bare RC frame alone. This is the most common design practice in the developing countries.

• Infills are built integral with the RC frame, and considered as structural elements. The in-plane stiffness offered by the infill walls is considered in the analysis of the building. The forces from this analysis are used in the design of RC frame members and joints.

INFLUENCE OF MASONRY INFILL WALLS:

Significant experimental and analytical research effort has been expended till date in understanding the behavior of masonry infilled frames [CEB, 1996]. Infills interfere with the lateral deformations of the RC frame; separation of frame and infill takes place along one diagonal and a compression strut forms along the other. Thus, infills add lateral stiffness to the building. The structural load transfer mechanism is changed from frame action to predominant truss action (Figure 1); the frame columns now experience increased axial forces but with reduced bending moments and shear forces.

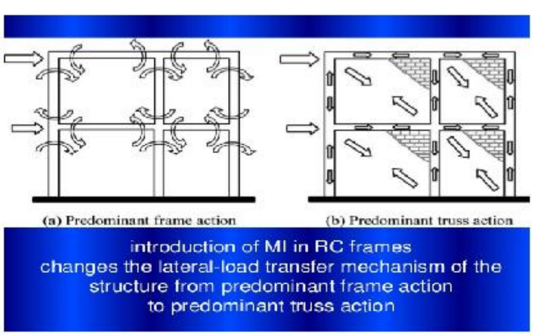


Figure 1: Change in the lateral load transfer mechanism owing to inclusion of masonry infill walls.

When infills are non-uniformly placed in plan or in elevation of the building, a hybrid structural load transfer mechanism with both frame action and truss action, may develop. In such structures, there is a large concentration of ductility demand in a few members of the structure. For instance, the soft-story effect (when a story has no or relatively lesser infill's than the adjacent story's), the short-column effect (when infill's are raised only up to a partial height of the columns), and plan-torsion effect (when infill's are unsymmetrically located in plan), cause excessive ductility demands on frame columns and significantly alter the collapse mechanism. Another serious concern with such buildings is the out-of-plane collapse of the infill's which can be life threatening. Even when the infill's are structurally separated from the RC frame, the separation may not be adequate to prevent the frame from coming in contact with the infill's after some lateral displacement; the compression struts may be formed and the stiffness of the building may increase.

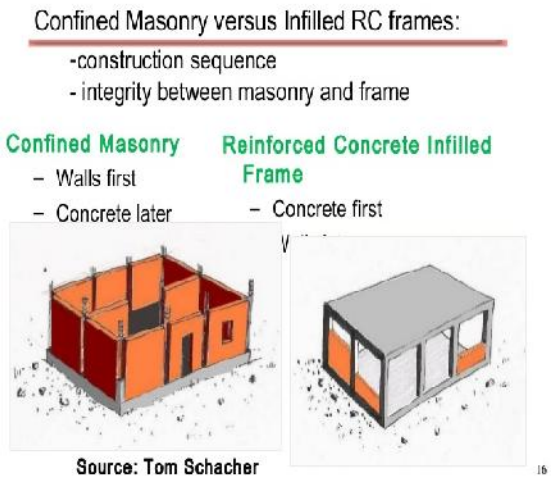
Infill's possess large lateral stiffness and hence draw a significant share of the lateral force. When infill's are strong, strength contributed by the infill's may be comparable to the strength of the bare frame itself. The mode of failure of an in filled building depends on the relative strengths of frame and infill (Table 1). And, its ductility depends on the (a) infill properties, (b) relative strengths of frame and infill, (c) ductile detailing of the frame when plastic hinging in the frame controls the failure, (d) reinforcement in the infill when cracking in infill's controls the failure, and (e) distribution of infill's in plan and elevation of the building.

In a bare frame, inelastic effects in RC frame members and joints cause energy dissipation, while in an infilled frame, inelastic effects in infills also contribute to it. Thus, energy dissipation in an infilled frame is higher than that in the bare frame. If both frame and infill are detailed to be ductile, then stiffness degradation and strength deterioration under cyclic loading are nominal. However, if inelastic effects are brittle in nature (e.g., cracking of infill, bond slip failure in frame, or shear failure in frame members), the drop in strength and stiffness under repeated loading may be large. When physical gaps exist between the frame and the infills, or when sliding takes place in infills along mortar beds, the hysteresis loops demonstrate increased pinching.

Here is a diagram which shows the laying of in filled frames .

INTRODUCTION:

Seismic analysis is a subset of structural analysis and is the calculation of the response of a building structure to earthquakes .A building has the potential to wave back and forth during an earthquake.This is called the fundamental modes and it is the lowest frequency of building response. Most of the buildings however have higher modes of response, which are uniquely activated during earth quakes.



3.3 SEISMIC ANALYSIS PROCEDURES:

Structural analysis(seismic analysis) methods can be divided into the following 5 categories:

1)Equivalent Static Analysis
2)Response Spectrum Analysis
3)Linear Dynamic Analysis
4)Non Linear Static Analysis
5)Non Linear Dynamic Analysis

3.3.1)Equivalent Static Analysis:

This method is perhaps the simplest procedure at disposal for a structural engineer to perform an earthquake analysis and achieve reasonable results. It is prescribed in any relevant code for earthquake analysis and is widely used especially for buildings and other common structures meeting certain regularity conditions.

The method is also called The Lateral Forces Method as the effects of an earthquake are assumed to be the same as the ones resulting from the statical transverse loadings

In the Rayleigh method, an inertia loading provides a good approximation to the natural vibration shape of the structure. If the structural response is not significantly affected by contributions from higher modes of vibration it is reasonable to assume that with an appropriate set of inertia forces one may achieve a good approximation for the response. This is the basic concept of the Equivalent Static Method.

One usual requirement for the structure regarding the application of this method is that the natural vibration period of the structure should be limited by a maximum value, which leads to a certain minimum value of frequency/stiffness. This is due to the fact that often the response is mainly controlled by the first mode of vibration. Thus, imposing a minimum value of frequency the higher modes contribution may be neglected.

The structure to be analysed by the equivalent static method should respect certain criteria regarding its geometrical regularity and stiffness distribution such as

1. All lateral load resisting elements (such as columns or walls) should run from the base to the top without any interruption
2. Mass and lateral stiffness should not change abruptly from the base to the top
3. Geometrical asymmetries in height or in plan due to setbacks should not exceed certain values

3.3.2)Response spectrum analysis:

This approach permits a multiple modes of response of a building to be taken into account(in the frequency domain).this is required in may building codes for all except for very simple or very complex structure. The response of a structure can be defined as a combination of many special shapes that in a vibrating string correspond to the harmonics. computer analysis can be used to determine these modes for a structure. For each mode a response is read from the design spectrum, Based on the modal frequency and the modal mass ,and they are then combined to provide an estimate of the total response of the structure.in this we have to calculate the magnitude of forces in all directions i.e., X,Y,Z and then see the effects on the building. combination methods include the following:

Absolute peak values are added together
Square rootof the sum of the squares
Complete quadratic combination

The result of response spectrum analysis using the response spectrum from a ground motion is typically different from that which would be calculated from linear dynamic analysis using that ground motion directly, since phase information is lost in the process of generating the response spectrum.

In cases where structures are either too irregular ,too tall the response spectrum approach is no longer appropriate and more complex analysis is often required, such as non linear static analysis or dynamic analysis

3.3.3)Linear dynamic Analysis:

As a result of recent developments in desktop computing capabilities and seismic analysis software, there has been a shift among practicing engineers toward the routine application of linear dynamic analysis rather than linear static analysis for multistoried buildings. The application of linear dynamic analysis is favored due to its ability to explicitly account for the effects of multiple modes of vibration. Furthermore, the results of linear dynamic analysis can be used to determine whether significant inelastic behavior is likely to occur and thus can be used to determine whether more complex static or dynamic nonlinear analysis is warranted.

In a linear dynamic procedure the building is modelled as a multi-degree-of-freedom (MDOF) system with a linear elastic stiffness matrix and an equivalent viscous damping matrix. The seismic input is modelled using either A) modal spectral analysis or B) time history analysis.

A)Modal spectral analysis assumes that the dynamic response of a building can be found by considering the independent response of each natural mode of vibration using linear elastic response spectra. Only the modes contributing considerably to the response need to be considered. The modal responses are compared using schemes such as the square-root-sum-of-squares (SRSS) & CQC (Complete Quadratic Combination)

SRSS (Square Root of Sum of Squares):

This is one of the most frequently used modal combination methods. According to this rule the maximum response in terms of a given parameter, G, (displacements, velocities, accelerations or even internal forces) may be estimated through the square root of the sum of the m modal response squares, , contributing to the global response, i.e.

$$G \approx \sqrt{\sum_{n=1}^{m} (G_n)^2}$$

This method usually gives good results if the modal frequencies of the modes contributing for the global response are sufficiently separated to each other. Otherwise another method, such as the one following, will be more adequate.

2) CQC (Complete Quadratic Combination) :

The reason why this method is more effective in evaluating the maximum response when the modal frequencies are close to each other is due to the fact that it considers the correlation between modal responses, whereas the SRSS method considers these to be independent. In fact if two vibration modes have close frequencies their contribution to the global response is not independent. Usually this method is used if $\omega_{n+1}/\omega_n \leq 1.5$. The correlation between modes i and n is estimated using the parameter, in ρ , given by the following expression:

$$\rho_{in} = 8.\ \xi^2 (1+\beta_{in})\ \beta_{in}^{3/2} / (1-\beta_{in}^2)^2 + 4\xi^2 \beta_{in} (1+\beta_{in})^2$$

The parameter in β_{in} is $\beta_{in} = \omega_i/\omega_n$.

The global response is achieved applying the following expression.

$$G \approx \sqrt{\sum_{n=1}^{m} \sum_{i=1}^{m} \rho_{in} G_i G_n}$$

B)Time-history analysis involves a time step- by-step evaluation of building response, using recorded or synthetic earthquake records as a base motion input. In both cases the corresponding internal forces and displacements are determined using again linear elastic analyses.

The advantage of these linear dynamic procedures with respect to linear static procedures is that higher modes can be considered which makes them suitable for irregular buildings. However, again they are based on linear elastic response and hence their applicability decreases with increasing nonlinear behaviour, which is approximated by global force reduction factors.

3.3.4) NONLINEAR STATIC ANALYSIS

A) Introduction

Pushover Analysis is a nonlinear static method of analysis. This analysis technique, also known as sequential yield analysis or simply “Pushover” analysis has gained significant popularity during past few years. It is one of the three analysis techniques recommended by FEMA 273/274 and a main component of Capacity Spectrum Analysis method (ATC-40). The following are the definitions which are most commonly used in Pushover Analysis.

B)Performance Point

It is the point where capacity spectrum intersects the appropriate demand spectrum (capacity equals demand). To have desired performance, every structure has to be designed for this level of forces. Desired performance with different damping ratios have been shown in Fig.3.1

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C)Building Performance Levels

Building performance is a combination of the performance of both structural and non-structural components. Different building performance levels, used to describe the performance of buildings in pushover analysis are described below.

Operational level (OL)

Buildings meeting this performance level are expected to sustain no permanent drift and the structure substantially retains original strengths and stiffness. Minor cracking of facades, partitions and ceilings as well as structural elements are seen. All systems important to normal operation are functional. Non-structural components are expected to sustain negligible damage. Power and other utilities are available, possibly from standby source.

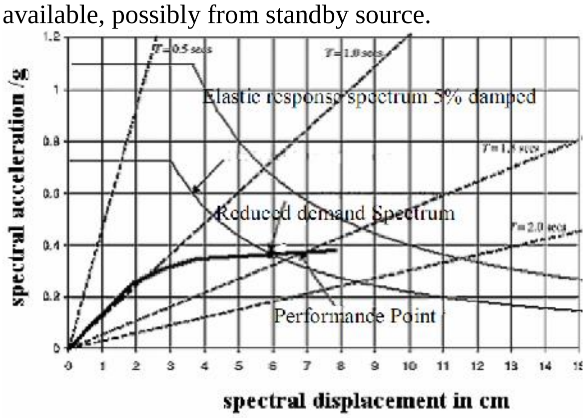

Figure-3.1 Determination of performance point

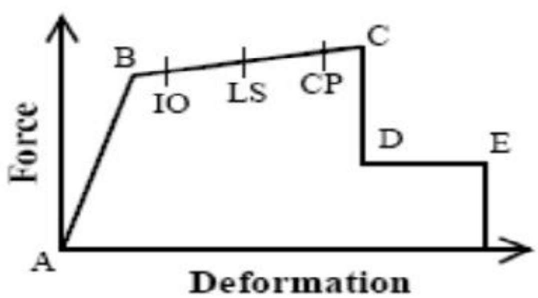

Figure-3.2 Hinge property

Immediate occupancy level

Non-structural Performance Level NP-B, Immediate Occupancy, means the post earthquake damage state in which only limited non-structural damage has occurred. In general, components of mechanical and electrical systems in the building are structurally secured and should be able to function if necessary utility service is available. The risk of life-threatening injury due to non-structural damage is very low.

Use of Pushover Results

Pushover analysis has been the preferred method for seismic performance evaluation of structures by the major rehabilitation guidelines and codes because it is conceptually and computationally simple. Pushover analysis allows tracing the sequence of yielding and failure on member and structural level as well as the progress of overall capacity curve of the structure. The expectation from pushover analysis is to estimate critical response parameters imposed on structural system and its components as close as possible to those predicted by nonlinear dynamic analysis. Pushover analysis provide information on many response characteristics that cannot be obtained from an elastic static or elastic dynamic analysis. These are [30];

- estimates of inter story drifts and its distribution along the height.
- determination of force demands on brittle members, such as axial force demands on columns, moment demands on beam-column connections.
- determination of deformation demands for ductile members.
- identification of location of weak points in the structure (or potential failure modes).
- consequences of strength deterioration of individual members on the behaviour of structural system.
- identification of strength discontinuities in plan or elevation that will lead to changes in dynamic characteristics in the inelastic range.
- verification of the completeness and adequacy of load path

Pushover analysis also exposes design weaknesses that may remain hidden in an elastic analysis. These are story mechanisms, excessive deformation demands, strength irregularities and overloads on potentially brittle members.

I)Limitations of Pushover Analysis

Although pushover analysis has advantages over elastic analysis procedures, underlying assumptions, the accuracy of pushover predictions and limitations of current pushover procedures must be identified. The estimate of target displacement, selection of lateral load patterns and identification of failure mechanisms due to higher modes of vibration are important issues that affect the accuracy of pushover results. Target displacement is the global displacement expected in a design earthquake.

The roof displacement at mass center of the structure is used as target displacement. The accurate estimation of target displacement associated with specific performance objective affect the accuracy of seismic demand predictions of pushover analysis.

In pushover analysis, the target displacement for a multi degree of freedom (MDOF) system is usually estimated as the displacement demand for the corresponding equivalent single degree of freedom(SDOF)system. The basic properties of an equivalent SDOF system are obtained by using a shape vector which represents the deflected shape of the MDOF system. The theoretical background for the determination of basic properties of equivalent SDOF system is given . Most of the researchers recommend the use of normalized displacement profile at the target displacement level as a shape vector but iteration is needed since this displacement is not known a priori. Thus, a fixed shape vector, elastic first mode, is used for simplicity without regards to higher modes by most of the approaches. Moreover, hysteretic characteristics of MDOF should be incorporated into the equivalent SDOF model, if displacement demand is affected from stiffness degradation or pinching, strength deterioration, P-Δ effects. Foundation uplift, torsional effects and semi rigid diaphragms are also expected to affect the target displacement. Lateral loads represent the likely distribution of inertia forces imposed on structure during an earthquake. The distribution of inertia forces vary with the severity of earthquake and with time during earthquake

There are many unsolved issues that need to be addressed through more research and development. Examples of the important issues that need to be investigated are:

- Incorporation of torsional effects (due to mass, stiffness and strength irregularities).
- 3-D problems (orthogonality effects, direction of loading, semi-rigid diaphragms, etc)
- Use of site specific spectra.
- Cumulative damage issues.
- Most importantly, the consideration of higher mode effects once a local mechanism has formed.

Since the pushover analysis is approximate in nature and is based on static loading, as such it cannot represent dynamic phenomena with a large degree of accuracy. It may not detect some important deformation modes that occur in a structure subjected to severe earthquakes, and it may significantly from predictions based on invariant or adaptive static load patterns, particularly if higher mode effects become important.

3.3..5) Non-Linear Dynamic Analysis:

In nonlinear dynamic procedure the building model is similar to the one used in non-linear static procedures incorporating directly the inelastic material response using in general finite elements. The main difference is that seismic input is modelled using a time history analysis, which involves time-step-by-time-step evaluation of the building response.

This is the most sophisticated analysis procedure for predicting forces and displacements under seismic input. However, the calculated response can be very sensitive to the characteristics of the individual ground motion used as seismic input; therefore several time-history analyses are required using different ground motion records. This most basic inelastic method at this time is considered overly complex and impractical for general use.

3.4 Advantages Of Inelastic Procedure Over Elastic Procedures.

Although an elastic analysis gives a good understanding of the elastic capacity of structures and indicates where first yielding will occur, it cannot predict failure mechanisms and account for redistribution of forces during progressive yielding. Inelastic analyses procedures help demonstrate how buildings really work by identifying modes of failure and the potential for progressive collapse. The use of inelastic procedures for design and evaluation is an attempt to help engineers better understand how structures will behave when subjected to major earthquakes, where it is assumed that the elastic capacity of the structure will be exceeded.

3.5SAFETY EVALUATION OF REINFORCED CONCRETE BUILDINGS

3.5.1 Introduction

Safety against collapse of reinforced concrete is usually defined in terms of its ductility ratios. The design of reinforced concrete structures is performed by using resistance smaller than the one required for the system to remain elastic under intense ground shaking. Then, the seismic codes implicitly cause structural damages during strong earthquake motions and the design relies on the capacity of the structures to undergo large inelastic deformations and to dissipate energy without collapse. This design methodology is used by all design standards including IS 1893.

3.5.2 SEISMIC VULNERABILITY

The vulnerability of a building subjected to an earthquake is dependent on seismic deficiency of that building relative to a required performance objective. The seismic deficiency is defined as a condition that will prevent a building from meeting the required performance objective. Thus, a building evaluated to provide full occupancy immediately after an event may have significantly more deficiencies than the same building evaluated to prevent collapse.

Depending on the vulnerability assessment, a building can be condemned and demolished, rehabilitated to increase its capacity, or

modified so that the seismic demand on the building can be reduced. Thus, structural rehabilitation of a building can be accomplished in a variety of ways, each with specific merits and limitations related to improving seismic deficiencies.

3.5..3 HOW DO BUILDINGS RESIST EARTHQUAKE FORCES?

As a building responds to ground motions produced by an earthquake, the bottom of the structure moves immediately, but the upper portions do not because of their mass and inertia. Figure-3.4 shows the base of a building moving while the upper part lags behind.

The horizontal force, or base shear, created by ground motion resulting from an earthquake must be resisted by the building. The more the ground moves, or the greater the weight of the building, the more force must be resisted by the building. When an architect or engineer designs a building, he or she must determine the maximum force a building might have to resist in the future. Buildings are always designed to handle normal vertical and lateral forces. However, once you introduce the possibility of an earthquake, a building must be designed for extraordinary horizontal or lateral forces. The horizontal (lateral) forces associated with an earthquake can be thought of as a lateral force applied to each floor and to the roof of a building. Figure 3.5 shows the vertical and horizontal forces on a building during an earthquake. Panel (a) shows the direction of gravitational forces on a building, panel (b) shows the horizontal force of seismic waves, and panel (c) shows the combined forces of gravity and an earthquake applied to the floors and roof of a building.

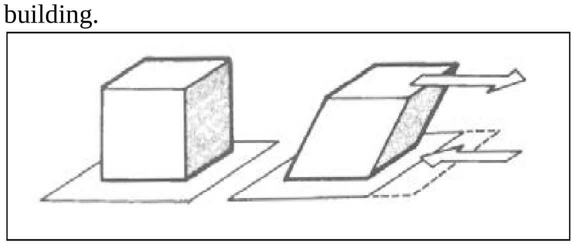

Fig -3.4 behaviour of building in ground acceleration

Horizontal forces accumulate along the floors and roof and then are distributed through the vertical supports into the foundation. A structural engineer must design a building so that lateral forces are distributed throughout the building without a break. Several structural systems, such as floors, walls, and columns, may be used in new buildings to reduce the effects of earthquakes and associated natural disasters.

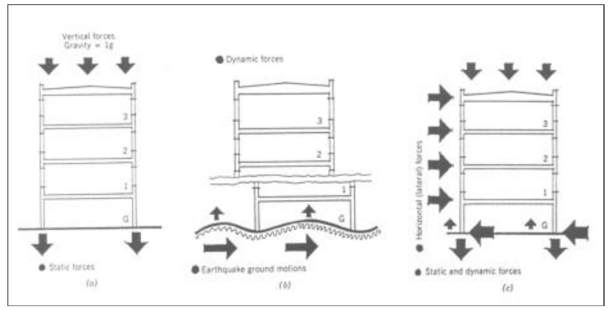

Fig –3.5 forces acting on the building during ground exitation

3.5.4 STIFFNESS:

A building is made up of both rigid and flexible elements. For example, beams and columns may be more flexible than stiff concrete walls or panels. Less rigid building elements have a greater capacity to absorb several cycles of ground motion before failure, in contrast to stiff elements, which may fail abruptly and shatter suddenly during an earthquake. Earthquake forces automatically focus on the stiffer, rigid elements of a building. For this reason, buildings must be constructed of parts that have the same level of flexibility, so that one element does not bend too much and transfer the energy of the earthquake to less ductile When the earthquake struck, the longer, more flexible columns at the front of the building passed the earthquake forces on to the short, stiffer columns in the back instead of distributing the forces equally among all of the columns. Deflection, the extent to which a structural element moves or bends under pressure, played a major role. The longer columns simply deflected or bent without cracking. The short columns, therefore, were overwhelmed and cracked.

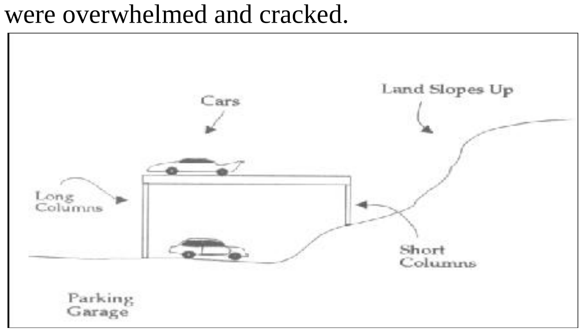

Fig3.6 showing long and short columns

SUMMARY AND CONCLUSION

The present work attempts to study the seismic response and performance level of different RC buildings located in seismic zone-V. In this study all important components of the building that influence the mass, strength, stiffness and deformability of the structure are included in the analytical model. To study the effect of infill and soft storey building models. The deflections at different storey levels and storey drifts are compared by performing response spectrum method as well as Further studies can be conducted on high rise buildings (sky-scrapers) by providing more thickness of shear walls. Studies can be conducted by providing shear wall at various other locations and also by providing dual system, which consists of shear wall (or braced frame) and moment resisting frame such that the two systems are designed to resist the total design force in proportion to their lateral stiffness considering the interaction of dual system at all floor levels. The moment resisting frames may be designed to independently resist at least 25% of design seismic base shear. For better ductility beam-column junction study can also be made. And further study an existing building can be considered for evaluation. Where, a preliminary investigation using FEMA-273 can be done before evaluation of the existing building using mathematical modelling with the help of FEA package and further it can be evaluated using Non-Linear Dynamic Analysis and other software's like sap &This investigation can also be done on Sloping RCC buildings constructed on hills in hill stations were land is at high cost and it will also attracts the tourists. Various damping mechanisms and its applications on structures can also be studied. Studies can also be conducted by modelling the structures having base

Reference

[1] Jaswant N. Arlekar, Sudhir K. Jain And C.V.R. Murty . "Seismic Response of RC Frame Buildings with Soft First Storeys". Proceedings of the CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, 1997, New Delhi..

[2] Shaik Kamal Mohammed Azam And Vinod Hosur . "Seismic behaviour of multi-storeyed buildings with soft intermediate storey". Journal of Structural Engineering Vol. 39, No. 3, August-September 2012 pp. 237-245.

[3] Amit V. Khandve. "Seismic Response of RC Frame Buildings with Soft Storeys". International Journal of Engineering Research and Applications (IJERA) Vol. 2, Issue 3, May-Jun 2012, pp.2100-2108.

[4] G V Mulgund et. al. "Seismic Assessment of Masonry Infill R C Framed Building with Soft Ground Floor". International Conference on Sustainable Built Environment (ICSBE-2010) Kandy, 13-14 December 2010.

[5] Shaik Kamal Mohammed Azam and Vinod Hosur. "Seismic Performance Evaluation of Multistoried RC framed buildings with Shear wall". International Journal of Scientific & Engineering Research Volume 4, Issue 1, January-2013.

[6] Misam.A et. al. "Structural response of soft story-high rise buildings under different shear wall location". International Journal Of Civil Engineering And technology (Ijciet)Volume 3, Issue 2, JulyDecember (2012), Pp. 169-180.

[7] Dr. Vinod Hosur. "Earthquake resistant design of building structures" Wiley India Pvt Ltd. New Delhi 110002.

[8] IS 456: 2000."Indian Standard Code of Practice for plain and reinforced Concrete", Bureau of Indian Standards, New Delhi.

[9] IS 1893(Part-I) 2002: Criteria for Earthquake Resistant Design of Structures, Part-I General Provision and Buildings (Fifth Revision). Bureau of Indian Standards, New Delhi.

[10] ETABS Non-linear 9.7 and SAP2000V15. Computers and Structures Inc, Berkeley.